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Relative Validity and Reproducibility of a Food Frequency Dietary Questionnaire for Use in the Italian EPIC Centres

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A pilot questionnaire was developed for the EPIC centres of northern Italy, and validated in the feasibility part of the cohort project. The questionnaire was self-administered and of the food frequency type with portion size estimated by means of pictures. It was structured by courses within a meal characteristic of Italian dietary habits. Dietary intake estimated by the questionnaire was compared to the corresponding estimates obtained from 8–14 24-hour recall interviews administered over a 1-year period. The reference method was validated by means of urinary nitrogen in 4–6 repeated 24-hour urine collections. One hundred and ninety-seven volunteers (47 men and 150 women) were enrolled and completed the study lasting 1 year. They filled out two questionnaires at the beginning and at the end of the study, and had a 24-hour recall interview once a month. Twenty-four-hour urine samples were collected at regular intervals. Usual intake of energy, the major nutrients and some vitamins were estimated for the questionnaires and the reference method by means of food composition tables compiled for this study.

The agreement between the questionnaire and the 24-hour recalls was only good for alcohol consumption: Pearson's correlation was 0.73 and 0.77 in men and women respectively. Otherwise the relative validity of the questionnaire ranged between 0.28 for fat to 0.52 for carbohydrates in men and 0.25 and 0.50 in women for the same nutrients. The validity of the two interview methods in estimating protein intake, compared to mean urinary nitrogen was 0.24 (M) and 0.18 (W) for the questionnaire and 0.63 (M) and 0.48 (W) for 24-hour recalls.

The main causes of low performance of the questionnaire were identified to be the estimated intake of dressing and cooking fats, vegetables and meat. Remedies were devised and introduced in the final version of the questionnaire currently in use in the EPIC project.

Keywords: diet, methodology, questionnaire, validity, Italy, EPIC

It is widely recognized that one of the main causes of uncertainty regarding the role of diet in the process of cancer causation is the intrinsic lack of accuracy of the method of assessing dietary intake. Food frequency questionnaires are often the preferred method for use in large prospective studies assessing the relationship between diet and disease outcome. This type of study involves the enrolment of thousands of volunteers and normal dietary intake needs to be estimated at the individual level, therefore financial and logistic constraints are particularly serious. It is therefore mandatory to reach an optimum compromise between the inaccuracy of the method used, unavoidable to some extent, and feasibility. Moreover, quantitative knowledge of the method's limitations will facilitate the interpretation of the study results and the inferences to be derived from them.

A pilot questionnaire, to be used in the EPIC centres of northern Italy, was developed and validated in the feasibility part of the cohort project. We present the results of the validation study and consequent modifications introduced to improve its performance.

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MATERIALS AND METHODS

The Pilot Questionnaire

The questionnaire was self-administered and of the food frequency type with portion size estimated by means of pictures. It was structured by courses within a meal characteristic of Italian dietary habits. The participant was asked to report his/her frequency of consumption of each of 47 dishes or food items (see Appendix). For 21 of these, pictures showing three portion sizes – arranged by increasing amount – followed the question on frequency, and the user had to choose one of the seven categories defined as follows: the three pictures, the two categories in between, and less than the smallest and more than the largest portion shown. A single photo was used to show typical 'units' of consumption for other items such as cups of milk and slices of bread. A life-sized picture showing 5 g of butter and a teaspoon of oil provided the units for quantifying seasoning and added fats. Additional questions addressed issues such as habitual cooking practices, type of cooking fats and changes in dietary habits due to seasonal variety. Possible answers to these questions were pre-defined by qualitative or ordered qualitative categories. The questionnaire was developed on the basis of that used in the ORDET prospective study on breast cancer[1] which had originally been drawn up in the light of the results of a survey conducted in the area to be covered by the EPIC project.[2] The dishes and food items selected for inclusion in the ORDET questionnaire were those which provided the highest contribution to the total between-subject variance of each of the following nutrients: total fat, saturated and polyunsaturated fats, proteins and vitamins A, C and β carotene. The items were selected by stepwise regression analysis. The questionnaire resulting from this procedure aims at correctly classifying individuals in relative categories of consumption.[3] Pictures to estimate portion size were included only for those dishes/food items where variance was significantly and independently affected by quantity and frequency of consumption.

As it was felt that the ORDET questionnaire was too limited for the purposes of the EPIC project, the main focus of which is usual diet, a simple survey was conducted in July 1989 in order to up-date and augment the old data. A large number of women already enrolled in the ORDET project were interviewed by phone about their food intake the previous day. No quantification was attempted. The aim of the survey was to estimate only the frequency of consumption of additional specific dishes and food items in the target population. A question on usual portion size (by means of three pictures) was then included in the pilot questionnaire if the item was consumed on average at least once a week.

The 24-hour Recall Interview

The 24-hour recalls performed in the Italian centres were open-ended interviews; information was collected using forms in which only a very limited number of basic food items were printed (i.e. sugar, bread, wine etc.); dieticians filled in the blank lines with the additional food items as reported by the interviewee. Dieticians were instructed to ask key questions to improve the qualitative description of food items, such as type of milk or the intake of the visible fat part of meat; however, no instrument was available during the interviews to ensure that details were not forgotten.

Quantification of single food items or complex dishes was obtained by using a variety of models, shapes and pictures. No rigid rule was given regarding which standard should be adopted for a given food item: the only rule was to allow the interviewee to choose the one he/she felt more comfortable with. The picture sets included those used in the questionnaire but concerned more items and a greater number of portion sizes per item (6–8 photos). The pictures were validated in an earlier study[4] which provided 'corrected' weights for the picture models.

A special procedure was adopted to collect information about complex dishes; for home preparations the interviewee was asked to provide the actual recipes of cooked dishes (individual recipes); the proportion of the whole preparation eaten by the interviewee was then estimated together with all other portions eaten by other people. Unknown recipes, for which only the name of the dish was recorded, were later replaced with a standard composition which accounted, to some extent, for the place where the dish was consumed (private home, restaurant, cafeteria) (standard recipes). Virtually all 24-hour recall interviews were conducted face-to-face at the recruitment centres.

Food Composition Tables

Nutrient intake was calculated according to food tables which were compiled for the purpose of the EPIC study,[5] on the basis of existing tables for Italy and other countries.[6,7]

Study Design

Figure 1 depicts the study design for the two centres. Every participant was asked to complete the questionnaire twice, at the beginning (Q1) and at the end (Q2) of the study period, 1 year apart; on the same occasions their height and weight were recorded. They were also asked to undergo a 24-hour recall interview every month for 12 months. The dates of the interviews were scheduled in advance in order to have the same occurrence of weekdays and bank-holidays for every participant.

Calendar	Questionnaire	24-hour recall	24-hour urine collection	
			(a)	(b)
Oct. 1989	X	X	X	
Nov.		X		X
Dec.		X	X	
Jan.		X		X
Feb.		X	X	
Mar.		X		X
Apr.		X	X	
May		X		X
June		X	X	
July		X		X
Aug.		X	X	
Sept.		X		X
	X			

(a) one half of the participants
(b) second half of the participants

FIGURE 1 *Study design*

Every 2 months the participants were asked to provide a 24-hour urine collection which they would deliver on the day of the 24-hour recall interview. Urine was collected in 1-litre plastic bottles containing 5 mg of boric acid. On delivery, participants answered a short questionnaire to check correctness and completeness of urine collection; they were then asked to repeat the collection if there seemed to be a loss of more than 50 ml. Participants were also asked to provide two blood samples, one at the beginning and one at the end of the study.

Recruitment of volunteers began in Autumn 1989. Participants were enrolled from the same populations identified as the sources of the EPIC prospective study: women attending a breast cancer screening centre in Varese and blood donors in Turin (men and women). The response rate among people invited to participate was rather low and the main reason for refusal was lack of time.

Table 1 shows the mean age and anthropometric measurements of the participants who completed the study, 47 men and 150 women. Eventually, the median number of 24-hour recalls obtained per individual was 10 for men and 11 for women. A few subjects did not fill out the second questionnaire (1 man and 7 women).

Total urine nitrogen content was determined by a modified Kieldahl technique.[8] Urine analyses were carried out at the Dunn Nutrition Laboratory (Cambridge, UK) under the supervision of Dr Bingham.

TABLE 1 *Means and standard deviations (SD) for age and some anthropometric characteristics of the participants, by sex*

	Men n = 47		Women n = 150	
	mean	SD	mean	SD
Age (years)	50.5	8.3	49.4	8.8
Weight (kg)	77.3	8.9	62.9	11.0
Height (cm)	171.6	5.1	159.0	5.7
BMI[a]	26.2	2.8	25.0	4.0

[a] Body Mass Index = Weight (kg)/(height [cm])^2

Analysis

The performance of the questionnaire was evaluated in terms of reproducibility (correlation between first and second questionnaire) and relative validity to the usual intake estimated by the repeated 24-hour recalls. The validity of protein intake estimated by the reference method was evaluated by comparing it with the average of the repeated 24-hour urine nitrogen.

The Spearman correlation was used to analyse agreement between methods in assessing food consumption, and Pearson's coefficient to analyse log-transformed nutrient intakes. Pearson's coefficient, corrected to account for intra-individual variation,[9,10] are also presented.

Results are reported separately for men and women as the latter are expected to perform better.

Mean food consumption was computed on the subset of consumers. Basal metabolic rates were calculated according to the age-specific formula provided by Schofield.[11]

RESULTS

Table 2 shows the number of non-consumers according to the questionnaire and the average daily intake of 16 food groups in grams, as estimated by the questionnaire and by the 24-hour recalls. We do not report the number of non-consumers given by the reference method, as 8–12 days is not long enough to estimate any consumption less frequent than once a week. The Table also shows percentage differences between the results obtained by the two methods. The most serious underestimations, in both sexes, were observed for consumption of cheese (–43% men [M], –44% women [W]), the group 'pasta and rice' (–32% M, –26% W) and soft drinks (–66% M, –28% W). The questionnaire gave overestimations in mean daily intake of fish (42% M,

TABLE 2 *Mean daily consumption (grams) of 16 food groups as assessed by the questionnaire (Q1) and the reference method (24-hour recall), by sex. Per cent difference between Q1 and 24-hour recalls; frequency of non-consumers assessed by Q1*

	Men n = 47				Women n = 150			
	Mean g/day Q1	24-hour recalls	% difference	No. of non-consumers	Mean g/day Q1	24-hour recalls	% difference	No. of non-consumers
Pasta & rice	200	295	–32	0	161	217	–26	0
Bread	150	170	–16	0	125	121	3	0
Meat	87	95	–9	0	84	90	–6	0
Fish	31	22	42	2	31	23	33	2
Eggs	15	16	–9	0	13	15	–13	0
Cheese	39	68	–43	0	33	59	–44	0
Vegetables	292	249	17	0	259	210	23	0
Potatoes	44	43	2	0	41	56	–26	0
Legumes	20	32	–37	1	18	19	–4	3
Fruit	457	335	36	2	454	371	22	1
Cakes	26	40	–35	2	48	49	–2	4
Added fats	61	52	17	0	45	36	27	0
Sugar	26	23	12	4	29	30	–3	10
Milk & milk products	152	140	8	1	182	169	8	0
Soft drinks	25	73	–66	1	37	52	–28	3
Alcoholic beverages	315	332	–5	2	132	125	5	37

33% W), fruits (36% M, 22% W), added fats (17% M, 27% W) and vegetables (17% M and 23% W). Men seemed to underestimate their consumption of cakes and sweets (–35%).

The reproducibility of the questionnaire and its relative validity in estimating food intake is evaluated in Table 3 which gives the Spearman correlation coefficient between the two questionnaires and between the first and the reference method, in men and women. In women the correlation between the two questionnaires ranged between 0.57 for bread and 0.85 for alcohol intake. The reproducibility of the information reported by men was similar or lower than that observed among women, for all food groups except 'potatoes' and 'milk and yoghurt'. The validity of the questionnaire appears very good only for the intake of alcoholic beverages: r = 0.83 (W) and r = 0.79 (M). The correlation coefficients for the other food groups vary from 0.15 to 0.67, women and 0.21 to 0.65, men. The worst performance for both sexes concerned the intake of 'soft drinks', 'added fats' and 'meat'. The correlation between the questionnaire and the reference method was lower than 0.40 for estimated consumption of potatoes, eggs, sugar, cakes and fruits in women, and vegetables, beans and bread in men. For the two sample sizes, 95% confidence intervals are given in the footnote of the Table. In men correlation values equal to or greater than 0.3 were significantly greater than zero, in women the threshold was at 0.2.

Table 4 shows the mean intakes of the 11 nutrients considered and of the four major contributors to total energy expressed as a percentage of the latter, estimated by the questionnaire and by the reference method. At the group level the questionnaire estimated a mean daily energy intake of 2453 kcal in men (–4.7% of the amount estimated by 24-hour recall) and 2094 kcal in women (–3.3). As observed for mean intake of food items, the direction of the questionnaire bias was similar in the two sexes for the majority of the nutrients; the intake of protein and cholesterol were underestimated by some 10–15%, whereas vitamin C and carotene were overestimated by 8–23% relative to the reference method. Women underreported their usual intake of alcohol (–12%).

The simple correlation coefficient computed on the log-transformed values of nutrients are given in Table 5. The reproducibility of the questionnaire was above 0.50 for all nutrients with the sole exception of protein in men (0.37). Agreement between the questionnaire and the reference method was, however, generally low except for alcohol (0.77 and 0.73 in women and men respectively). The most serious bias occurred for fat (the correlation is 0.25 in women and 0.28 in men) and for protein estimated for women (0.25). The relative

TABLE 3 *Reproducibility and relative validity of the questionnaire: Spearman correlation coefficients between daily consumption of 16 food groups estimated by the two questionnaires (Q1–Q2) and by first questionnaire and reference method (Q1–24-hour recalls [24HDRs]), by sex*

Food groups	Men		Women	
	n = 46 Q1–Q2	n = 47 Q1–24HDRs	n = 143 Q1–Q2	n = 150 [a]Q1–24HDRs
Pasta & rice	0.74	0.65	0.71	0.54
Bread	0.31	0.21	0.57	0.41
Meat	0.62	0.39	0.66	0.38
Fish	0.73	0.42	0.75	0.47
Eggs	0.56	0.50	0.62	0.23
Cheese	0.63	0.41	0.64	0.45
Vegetables	0.69	0.30	0.71	0.45
Potatoes	0.73	0.40	0.63	0.24
Legumes (pulses)	0.69	0.33	0.76	0.40
Fruit	0.64	0.56	0.62	0.39
Cakes	0.69	0.57	0.74	0.34
Added fats	0.48	0.34	0.60	0.30
Sugar	0.62	0.51	0.66	0.26
Milk & milk products	0.84	0.85	0.73	0.67
Soft drinks	0.73	0.30	0.72	0.15
Alcoholic beverages	0.87	0.79	0.85	0.83

[a] 95% confidence intervals:
n = 47: –0.09–0.46 for r = 0.2; 0.01–0.54 for r = 0.3; 0.13–0.62 for r = 0.4; 0.25–0.69 for r = 0.5; 0.38–0.76 for r = 0.6; 0.52–0.82 for r = 0.7; 0.67–0.88 for r = 0.8.
n = 150: 0.04–0.35 for r = 0.2; 0.15–0.44 for r = 0.3; 0.26–0.53 for r = 0.4; 0.37–0.61 for r = 0.5; 0.49–0.69 for r = 0.6; 0.61–0.77 for r = 0.7; 0.73–0.85 for r = 0.8.

validity of the questionnaire completed at the end of the study period (Q2) was very similar to that of Q1 among women: correlation coefficients between Q2 and 24-hour recalls were within ±0.04 the corresponding coefficient measured for Q1. On the contrary, some important changes were observed among men: no correlation between the two methods in estimating fat intake (r = –0.07) and vitamin E (r = –0.08) and an improvement of the questionnaire relative to the reference for dietary fibre (r = 0.50) and the other three vitamins (vitamin C [r = 0.51], retinol [r = 0.60] and β-carotene [r = 0.41]).

The potential accuracy of the questionnaire, when corrected for the attenuation due to intra-individual day-to-day variation, is described by the corrected correlation coefficients reported in Table 6 which also shows the agreement between the two dietary instruments for energy-adjusted nutrients. This shows that attenuation may account for only a small part of the bias with the sole exception of cholesterol, the validity of which was improved (from the simple correlation of 0.47 to 0.61). The validity of the estimated intake of energy was 0.39 in men and 0.35 in women. Fats still showed the lowest agreement with the reference: 0.33 (M) and 0.27 (W). The correlation between residual of nutrients above their contribution to total energy intake paralleled the correlation between their absolute values. Although these were improved by the correction for attenuation, the advantage appeared rather small with the exception of cholesterol in men.

Table 7 shows the correlation between estimated intake of protein by Q1 and 24-hour recalls with individual mean urinary nitrogen. The correlation between 24-hour recalls and the biological marker were 0.63 in men and 0.48 in women. Questionnaire accuracy was better in men than in women (0.24 and 0.18 respectively), although rather poor for both.

DISCUSSION

The study design satisfied the methodological standards generally accepted for this type of evaluation.[12,13] The results were therefore interpreted in a straightforward way as indicating the weakest parts of the questionnaire.

Inaccuracy in estimating the intake of some items was expected, although quantitatively unknown. This is the case for fruit, vegetables, and seasoning and cooking fats. Fat is commonly added when preparing main courses for the whole family, so that individual portions of these can hardly be estimated by the consumer, especially if he/she did not cook the dish. If this is the case, a consequence would be that the self-administered questionnaire cannot be substantially improved; it is even possible that attempts to quantify added fats independently of the size of the dish portion may lead to an increase in the random error rather than to greater accuracy. Accuracy should be greater for information obtained in interviews administered by trained dieticians. In the study of the validity of a food frequency questionnaire (FFQ) designed to describe dietary habits in Northern Italy, De Carli[14] report a correlation of 0.47 between total fat intake estimated through the questionnaire administered by trained interviewers, when compared to two 7-day records. It is interesting to note that in the same study the correlation for fat of vegetable origin, the source of which is mostly oil and margarines used to season and cook, was only 0.27.

The main source of error in estimating the intake of vegetables and fruits is the wide variety of items available

TABLE 4 *Means and SD of nutrient daily intake and of macronutrients' per cent contribution of total energy, according to the questionnaire (Q1) and the reference method (24-hour recalls), by sex. Difference between assessment methods is expressed as (Q1–24-hour recalls)/ 24-hour recall * 100*

	Men n = 47					Women n = 150				
	Q1		24-hour recall			Q1		24-hour recall		
	mean	SD	mean	SD	% difference	mean	SD	mean	SD	% difference
Energy	2453	697	2575	557	–4.7	2094	608	2164	532	–3.3
Protein	78	22	93	18	–16.1	74	21	82	20	–9.8
Carbohydrates	270	86	282	69	–4.3	257	90	258	69	–0.3
Fats	96	41	102	42	–6.5	80	30	86	37	–7.5
Cholesterol	269	114	318	104	–15.1	268	92	322	131	–16.8
Alcohol	32	26	32	25	2.2	11	12	12	12	–11.5
Dietary fibre	25	9	23	6	7.4	23	11	22	7	7.0
Vitamin C	148	56	138	66	7.6	143	74	128	63	11.8
Retinol	500	410	467	658	7.0	528	426	576	749	–8.3
Carotene	4463	2304	3941	1964	13.2	4206	2125	3421	1928	22.9
Vitamen E	14	5	15	10	–6.2	11	4	11	7	3.7
% energy										
Alcohol	10	8	8	6	14.3	4	4	4	4	–7.5
Carbohydrates	44	8	44	8	–0.2	49	8	48	8	1.2
Fats	34	8	35	9	–2.3	34	7	35	8	–2.6
Protein	13	2	15	3	–12.2	15	3	15	3	–5.8
EI/BMR ratio[a]	1.42	0.38	1.51	0.39		1.55	0.46	1.60	0.40	

[a] Energy intake/basal metabolic rate.[11]

TABLE 5 *Reproducibility and relative validity of the questionnaire: Pearson correlation coefficients between daily intake of total energy and 10 nutrients (log-transformed) estimated by the two questionnaires (Q1–Q2) and by first questionnaire and reference method (Q1–24-hour recall), by sex*

	Men		Women	
	n = 46 Q1–Q2	n = 47 Q1–24HDR	n = 143 Q1–Q2	n = 150 Q1–24HDR
Energy	0.60	0.34	0.61	0.32
Protein	0.37	0.32	0.57	0.25
Carbohydrates	0.65	0.52	0.66	0.50
Fats	0.50	0.28	0.57	0.25
Cholesterol	0.56	0.47	0.63	0.34
Alcohol	0.83	0.73	0.81	0.77
Dietary fibre	0.69	0.38	0.67	0.48
Vitamin C	0.65	0.32	0.73	0.49
Retinol	0.56	0.37	0.57	0.40
β-carotene	0.69	0.32	0.64	0.34
Vitamin E	0.64	0.30	0.62	0.31

See footnote to Table 3.

during the year. The majority of these items contribute substantially to the characteristic nutritional habits of the population, even if available and consumed for short time periods; consequently, although individual consumption may be quite stable for the food group, any attempt to divide the whole into small components may lead to high misclassification rates. This problem is illustrated by the following figures: out of the 238 vegetable items (including raw and cooked varieties) recorded in the 24-hour recall, 76% are consumed for less than 3 months of the year or, equivalently, less than twice a week and consumers of these are less than 25% of the sample population of 197 individuals (but not the same 25% for each food item!).

Another important source of bias in characterizing usual dietary habits both qualitatively and quantitatively is the socio-cultural heterogeneity of the population studied. Traditional habits in cooking practices are quite distinct throughout the country and tend to persist in migrants and their descendants. The questionnaire validated in this study was developed in the light of a large population survey previously mentioned. The findings of this survey show that the average daily

TABLE 6 *Relative validity of the questionnaire: simple correlation coefficients (Pearson on log-transformed values) and attenuation-adjusted correlation coefficients, between daily intake of total energy, 10 nutrients and energy-adjusted nutrients as assessed by the questionnaire and reference 24-hour recalls, by sex*

	Men n = 47				Women n = 150			
	r(a)	r(b)	r(c)	r(d)	r(a)	r(b)	r(c)	r(d)
Energy	0.34	0.39			0.32	0.35		
Protein	0.32	0.39	0.30	0.35	0.25	0.30	0.38	0.48
Carbohydrates	0.52	0.58	0.45	0.52	0.50	0.55	0.46	0.54
Fats	0.28	0.33	0.27	0.31	0.25	0.27	0.32	0.41
Cholesterol	0.47	0.61	0.46	0.60	0.34	0.39	0.34	0.44
Alcohol	0.73	0.76	0.72	0.76	0.77	0.80	0.77	0.80
Dietary fibre	0.38	0.43	0.44	0.51	0.48	0.52	0.46	0.51
Vitamin C	0.32	0.38	0.37	0.44	0.49	0.56	0.41	0.49
Retinol	0.37	0.44	0.29	0.37	0.40	0.46	0.36	0.46
Carotene	0.32	0.39	0.38	0.47	0.34	0.40	0.34	0.42
Vitamin E	0.30	0.34	0.42	0.48	0.31	0.34	0.33	0.38

r(a) = simple correlation.
r(b) = correlation corrected for attenuation.
r(c) = simple correlation of energy-adjusted nutrients.
r(d) = correlation corrected for attenuation, of the energy-adjusted nutrients.

TABLE 7 *Simple correlation between average urinary nitrogen on repeated 24-hour urine collections, and estimated protein intake according to the questionnaire and the 24-hour recalls, by sex*

	Men n = 46	Women n = 150
Q1	0.24	0.18
24-hour recalls	0.63	0.48

intake of butter among residents originating from central and southern Italy (23% of the population of the study area) is less than half that of the native population and that southern Italians consume less saturated fat and more vegetables than northern people. Another 11% of the population is represented by people born in north-eastern regions also showing significantly different cooking habits.[15]

As an indicator of the large variability of preparations observed in our study we recorded 707 individual recipes and 632 standard recipes (not home-made) composed of at least five ingredients, in 2231 total 24-hour recalls. The qualitative variety is indicated by a total of 394 different vegetable and fruit items recorded in the 24-hour recalls.

The intrinsic complexity of the information to be collected also affects the performance of the reference method. Lack of accuracy of the reference method decreases the apparent performance of the questionnaire when the two are compared, the relative validity of the questionnaire therefore may underestimate the real one. Indeed 24-hour recalls are affected by a substantial error as can be judged by the correlation between estimated protein intake and urinary nitrogen. In fact, pictures of portion size for meat dishes—used for both methods—poorly estimated the actual quantity eaten as shown when the set of pictures were validated;[4] however, the source of the error, being common to the two methods, would in fact increase their correlation.

Other sources of error are due to the specific assessment method adopted. As the questionnaire was self-administered, an effort was made to simplify the formulation of questions with the aim of reducing subjective interpretation; this may have resulted in an over-simplification of complex but common recipes and over-pooling of some food items. The clearest example concerns the large group ‘cakes, biscuits, puddings, ice cream and desserts’ where quantification was limited to three questions concerning frequency, and the whole group was split into biscuits, creamy and non-creamy desserts.

The usual tendency of FFQ towards a generalized overestimation was controlled through questions concerning

the frequency of consumption of entire groups (e.g. 'a first course' which groups Pasta, Rice and all Soups). This information was used to 'normalize' the frequency reported for subgroups. This kind of summary question was not present for the group 'vegetables' the total frequency of which was indeed overestimated (Table 2).

The final version of the questionnaire to be used in the cohort study, was developed taking into account these observations and giving particular attention to four sections:

1. *Added fats*. All questions concerning the amount of fat added in specific preparations were taken out. Quantity will be estimated as a standard amount depending on the individual portion size of the whole preparation.
2. *Fruit and vegetable*. The number of questions concerning frequency of consumption of specific items or subgroups was increased from 24 to 32 and summary group-frequencies are also obtained.
3. *Pastry and creamy sweets*. Frequency of ice cream consumption is now estimated as a separate item, and summer/winter consumption is specified. The relative frequency of different types of puddings is also obtained and will be used to attribute individual weights to the specific items in the group.
4. *Meat*. Two sets of pictures to estimate portion size were replaced (steaks and cured pork meat). Specific questions were added for the consumption of cured pork in the form of sausages and lamb and offal.

Other additions concern the intake of shellfish, omelettes, nuts and seeds and the use of mayonnaise.

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APPENDIX A

Dishes and food items listed in the FFQ, for which frequency of consumption was collected; quantity estimation is indicated by the inclusion of pictures of portion sizes or other units; additional questions on quality and quantity of added fats are indicated in the second column.

Dishes and food items	Added fats	No. of pictures	Additional questions	Food groups used in analysis to which the item contributes
First courses:				
Pasta	X	3	X	pasta & rice, vegetables, meat
Rice	X	3	X	pasta & rice
Soups	X	3	X	pasta & rice, vegetables, potatoes
Stuffed pasta, polenta	X		X	pasta & rice, eggs, cheese, vegetables, meat
Pizza				bread, cheese, vegetables
Main courses:				
Steaks	X	3	X	meat
Roasted meat	X	3	X	meat
Stewed meat	X	3	X	meat
Liver				meat
Poultry		3		meat
Pork			X	meat
Cured meats and salami		3	X	meat
Canned meat				meat
Fish	X	3	X	fish
Canned fish			X	fish
Cheese		2×3	X	cheese
Eggs/omelets				eggs
Raw vegetables:				
Tomatoes	X	3	X	vegetables
Salad	X	3		vegetables
Carrots	X	3		vegetables
Mixed salad	X	3		vegetables
Cooked vegetables:				
Boiled leafy vegetables	X	3		vegetables
Carrots	X	3		vegetables
Broccoli/cabbage				vegetables
Fruit vegetables		3		vegetables
Artichoke/fennel/onions			X	vegetables
Legumes (pulses)			X	legumes
Fried potatoes	X			potatoes
Roasted potatoes	X	3		potatoes
Boiled potatoes	X			potatoes
Mashed potatoes	X	3		potatoes, milk & milk products
Fruit				
Non-citrus fruits		N[a]	X	fruit
Citrus fruits		N[a]	X	fruit
Beverages				
Wine		1		alcoholic beverages
Spirits				alcoholic beverages
Beer				alcoholic beverages
Soft drinks				soft drinks
Tea				
Coffee				
Other meal components:				
Bread/salted biscuits		1		bread
Pastries/ice creams			X	cakes
Sweet biscuits		N[a]		cakes
Cakes				cakes
Sandwiches		3		bread, cheese, meat, fish, added fats, vegetables
Milk		1	X	milk & milk products
Yogurt			X	milk & milk products

[a] N = number of natural units